

Question			Expected Answer	Mark	Additional Guidance
1	(a)	(i)	<p><b>X</b> adenine ;</p> <p><b>Y</b> ribose ;</p> <p><b>Z</b> (tri / 3) phosphate(s) ;</p>	3	<p><b>Mark the first answer for each letter.</b> If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = <b>0 marks</b></p> <p><b>X IGNORE</b> nitrogenous base / base / A <b>DO NOT CREDIT</b> adenosine</p> <p><b>Y IGNORE</b> pentose / sugar <b>DO NOT CREDIT</b> ribulose / hexose</p> <p><b>Z IGNORE</b> chemical formulae (as Q asks for name) <b>DO NOT CREDIT</b> phosphorus / phosphoryl (PO)</p>

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1	(a)	(ii)	<p>1 transfers energy / energy 'currency' / releases energy / universal energy molecule / energy intermediate / (immediate) source of energy ;</p> <p>2 phosphate(s) can be removed by <u>hydrolysis</u> ;</p> <p>3 to , release / provide , 30kJ (mol<sup>-1</sup>) energy ;</p> <p>4 (energy released for) metabolism / appropriate named reaction / appropriate reaction described ;</p> <p>5 ADP can attach a phosphate (forming ATP) during , respiration / photosynthesis ;</p> <p>6 energy released in , small 'packets' (to prevent cell damage) / suitable quantity ;</p>	3 max	<p>1 <b>IGNORE</b> contains energy <b>DO NOT CREDIT</b> produce energy</p> <p>2 ATP → ADP + P<sub>(i)</sub> by <u>hydrolysis</u> <b>or</b> ATP + H<sub>2</sub>O → ADP + P<sub>(i)</sub> (must include water)</p> <p>3 <b>ACCEPT</b> 28 – 32 <u>kJ</u> <b>DO NOT CREDIT</b> produce energy</p> <p>4 e.g. • muscle contraction • active transport • phosphorylation • glycolysis • during movement binding to proteins to change their shape <b>IGNORE</b> respiration / photosynthesis unqualified</p> <p>5 <b>CREDIT</b> during, oxidative phosphorylation / chemiosmosis / substrate level phosphorylation / photophosphorylation</p> <p><b>NOTE</b> 'it releases 30kJ of energy when a phosphate is removed by hydrolysis' = 3 marks (mps 3, 1 and 2)</p>

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1	(b)	(i)	crista ;		1	<p><b>Mark the first answer.</b> If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = <b>0 marks</b></p> <p><b>ACCEPT</b> 'cristae' / 'inner mitochondrial membrane'  <b>IGNORE</b> 'stalked particles'</p>
1	(b)	(ii)	chemiosmosis / oxidative phosphorylation ;		1	<p><b>Mark the first answer.</b> If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = <b>0 marks</b></p> <p><b>IGNORE</b> description of chemiosmosis  [e.g. • 'ATP synthesis'  • 'electron flow along electron carriers']</p> <p><b>IGNORE</b> 'aerobic respiration'  <b>IGNORE</b> 'electron transport chain' alone  (as this is not a process)</p>
1	(c)	(i)	1	<u>substrate</u> respired changes over time ;	3 max	<p><b>1</b> Needs to be a clear statement and not just names and not inferred from candidate's complete answer</p> <p><b>2</b> <b>IGNORE</b> respiring protein</p> <p><b>3</b> <b>IGNORE</b> respiring protein</p> <p><b>5</b> 'Less protein respired' isn't quite enough for this mp</p>
		2	initially respire (mostly) , glucose / carbohydrate ;			
		3	lower / decrease in / 0.75 , RQ indicates (more) , fat / lipid , as substrate <b>or</b> as time goes by (more) lipid is respired ;			
		4	glucose / carbohydrate , used up / decreases (over time) ;			
		5	protein not likely to be used as substrate / protein only used as a last resort ;			

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1	(c)	(ii)	<p><i>This is a QWC question</i></p> <p>1   <b>peripheral</b> / skin , <b>thermoreceptors</b> / (heat) receptors , stimulated (by decrease in external temp) ;</p> <p>2   (impulses sent to / blood temperature monitored in ) <b>hypothalamus</b> / sensory <b>cortex</b> ;</p> <p>3   <b>vasoconstriction</b> of , arterioles / small arteries , to reduce heat loss ;</p> <p>4   (prevents heat loss by) <b>radiation</b> / <b>conduction</b> / <b>convection</b> ;</p> <p>5   increased , <b>metabolic rate</b> / <b>metabolism</b> / respiration , to generate heat (energy) ;</p> <p>6   (release of) <b>adrenaline</b> / <b>thyroxine</b> ;</p> <p>7   shivering / (involuntary) muscle spasms , to generate heat (energy) ;</p> <p>8   <b>erector</b> / hair , muscles raise , (skin) hair / fur , to trap , air / heat ;</p> <p>9   <b>AVP</b> ;</p>	4 max	<p>Only <b>CREDIT</b> answers that refer to <b>preventing a decrease</b> in body temperature – no <b>ora</b></p> <p><b>IGNORE</b> negative feedback (Q only about preventing decrease)</p> <p>3   <b>ACCEPT</b> 'pre-capillary sphincter' instead of 'arterioles' <b>DO NOT CREDIT</b> other blood vessels <b>but allow QWC</b></p> <p>5   Emphasis needs to be on increase / higher rate / more</p> <p>7   Needs the idea of generating heat not just 'to keep warm'</p> <p>9   e.g. • specific behavioural response (such as huddling / increased exercise / move to find sun) • involvement of sympathetic nervous system • reduce sweating / reduce panting / stop panting <b>DO NOT CREDIT</b> 'stop sweating'</p>
		<p><b>QWC</b> - technical terms used appropriately and spelt correctly ;</p>	<p>Use of <b>three</b> terms from:  <b>peripheral,</b>                            <b>thermoreceptor(s),</b>  <b>hypothalamus,</b>                     <b>cortex,</b>  <b>vasoconstriction,</b>                <b>metabolic rate / metabolism,</b>  <b>adrenaline,</b>                           <b>thyroxine,</b>  <b>erector</b>                                 <b>radiation / conduction / convection</b></p> <p>Please insert a QWC symbol next to the mark total bracket, followed by  a tick (✓) if QWC has been awarded  or a cross (×) if QWC has not been awarded  You should use the green dot to identify the QWC terms that you are crediting.</p>		
<b>Total</b>				<b>[16]</b>	

Question		Expected Answers	Marks	Additional Guidance
2	(a)	<u>glycolysis</u> / <u>glycolytic pathway</u> ;	1	<b>Mark the first answer.</b> If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = <b>0 marks</b>  <b>CREDIT</b> phonetic spelling but must have 'glycol...'
2	(a)	cytoplasm ;	1	<b>Mark the first answer.</b> If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = <b>0 marks</b>  <b>CREDIT</b> cytosol <b>DO NOT CREDIT</b> cytoplasm, in / of, mitochondrion
2	(a)	(  D     ATP ; E     NAD ;  F     pyruvate ;	3	<b>Mark the first answer for each letter.</b> If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = <b>0 mark</b>  E <b>ALLOW</b> oxidised NAD <b>DO NOT CREDIT</b> NADP / reduced NAD F <b>ACCEPT</b> pyruvic acid

Question		Expected Answers	Marks	Additional Guidance
2	(b)	<p>1 (pyruvate / F) converted to lactate ;</p> <p>2 F / pyruvate , accepts hydrogen (atoms) ;</p> <p>3 hydrogen from , <b>reduced</b> NAD / <b>reduced E</b> ;</p> <p>4 (catalysed by) <u>lactate</u> dehydrogenase ;</p> <p>5 no, oxygen / O<sub>2</sub> , to act as (final), hydrogen / electron, acceptor ;</p> <p>6 (so) link reaction / Krebs cycle / ETC, cannot take place ;</p> <p>7 NAD / E, regenerated / recycled / able to be re-used ;</p> <p>8 allows glycolysis to continue / pyruvate continues to be made ;</p> <p>9 limited / small amount of / some, ATP can be produced ;</p>	5 max	<p><b>Award marks from labelled / annotated diagrams – but ensure that mp 2 only awarded if H clearly shown to be accepted by pyruvate</b></p> <p>1 <b>ACCEPT</b> lactic acid <b>DO NOT CREDIT</b> if pyruvate → ethanol in the animal is indicated/implicit <b>DO NOT CREDIT</b> wrong reaction type (e.g. oxidation)</p> <p>2 <b>ACCEPT</b> pyruvic acid <b>DO NOT CREDIT</b> hydrogen <b>ions</b> (unless also e<sup>-</sup>) / molecules</p> <p>3 <b>ACCEPT</b> NADH / NADH<sub>2</sub> / NADH + H<sup>+</sup></p> <p>4 for pyruvate → lactate <b>ACCEPT</b> LDH</p> <p>6 Needs a clear statement of <b>not</b> taking place <b>CREDIT</b> no , electron transport chain / electron carrier chain / chemiosmosis / oxidative phosphorylation</p> <p>7 <b>IGNORE</b> reduced NAD , oxidised / reoxidised (as this does not give the idea of reusing it)</p> <p>8 Needs a clear statement</p> <p>9 <b>CREDIT</b> 1 ATP (per pyruvate) / 2 ATP (rather than 28-38 per glucose) / only substrate level phosphorylation <b>IGNORE</b> 'enough ATP for ...'</p>

Question		Expected Answers		Marks	Additional Guidance
2	(c)	1	<i>physical (probably from diagrams)</i> large nostrils (open) to take in air ;	<b>S &amp; C</b>	1 <b>ACCEPT</b> oxygen
		2	(when submerged) nostrils close / nose closes , to , keep air in / stop air from escaping ;		2 <b>ACCEPT</b> oxygen <b>IGNORE</b> ref to keeping water out
		3	lungs / airways , have high (vital) capacity ;		3 <b>ACCEPT</b> deep / barrel / large , chest <b>IGNORE</b> big lungs <b>CREDIT</b> large lung <u>volume</u> / takes in large <u>volume</u> of oxygen / larger numbers of alveoli / larger (exchange) surface area / increased number of capillaries
		4	<i>links to respiration</i> <i>idea that seal</i> , has low(er) metabolic rate / has low(er) respiratory rate / has low(er) energy requirements / uses (relatively) little ATP ;		4 e.g. • (streamlined, less resistance so) uses less energy • (insulated so retain heat so) uses less energy • (buoyant so) less energy required • (small flippers so less surface area of extremity so loses less heat so) uses less energy
		5	able to respire anaerobically for a long time / more glycolysis ;		5 'anaerobic' needs time ref
		6	large supplies of NAD (to accept H) ;		
		7	(this) prevents , build-up of lactate / lowering of pH ;		7 <b>ACCEPT</b> lactic acid
		8	<i>idea that</i> (seal) tolerates lactate / removes lactate quickly ;		8 <b>ACCEPT</b> lactic acid
		9	<i>idea that</i> (seal) tolerates high CO <sub>2</sub> concentration ;		
		10	<i>idea that</i> (seal) tolerates low pH / has <b>more</b> pH buffers ; <i>synoptic / inference</i>		
		11	<i>idea that</i> blood diverted from certain regions / certain regions have reduced metabolic activity ;		11 <b>DO NOT CREDIT</b> zero respiration rate
		12	<i>idea that</i> has plenty of , haemoglobin / red blood cells / myoglobin (as oxygen source) ;		
		13	<i>idea that</i> haemoglobin has a higher affinity for oxygen / dissociates less readily / dissociation curve shifted to <b>left</b> ;		<b>3 max</b>
<b>Total</b>				<b>13</b>	

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3	(a)	(i)	<p>1 lag phase / slow increase (in , population / number / percentage) , at start / initially / day 0 - 1 / during day 1 ;</p> <p>2 log phase / exponential increase / rapid increase , day 1 - 3 ;</p> <p>3 <u>rate of increase</u> , slows / less steep , days 3 - 4 / during day 3 ;</p> <p>4 stationary phase / population levels off / population stays at 100% , at end / finally / remaining days / days 4 - 6 ;</p> <p>5 comparative figures quoted with 2 x-y readings ;</p>		<p><b>IGNORE</b> explanations <b>ACCEPT</b> 'the population grows' or 'it grows' (rather than increase) <b>DO NOT CREDIT</b> 'yeast grow(s)'</p> <p>1 <b>ACCEPT</b> days 0 - 0.9 <b>ACCEPT</b> lasts 1 day</p> <p>2 <b>ACCEPT</b> days 0.9 - 3.5</p> <p>3 <b>ACCEPT</b> days 3.3 - 3.6</p> <p>4 <b>ACCEPT</b> after day 3.5 - 4</p> <p>5 Each unit must be quoted at least once</p> <table border="1" data-bbox="1346 921 1892 1132"> <thead> <tr> <th>Time (days)</th> <th>Yeast (% final population)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>24</td> </tr> <tr> <td>1</td> <td>32</td> </tr> <tr> <td>3</td> <td>90</td> </tr> <tr> <td>3.5 - 6</td> <td>100</td> </tr> </tbody> </table> <p><b>Take care to distinguish between an increase in percentage (by either quoting the figures for the days or by calculating the difference) and a <i>percentage increase</i>.</b></p>	Time (days)	Yeast (% final population)	0	24	1	32	3	90	3.5 - 6	100
Time (days)	Yeast (% final population)														
0	24														
1	32														
3	90														
3.5 - 6	100														
				4 max											



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3	(a)	(ii)	<p>1 sugar converted to ethanol ;</p> <p>2 in <u>anaerobic respiration</u> ;</p> <p>3 sugar , undergoes glycolysis / converted to pyruvate ;</p> <p>4 pyruvate , loses carbon dioxide / decarboxylated / forms ethanal ;</p> <p>5 reduced NAD giving hydrogen to <u>ethanal</u> ;</p> <p>6 <i>idea of</i> NAD being , regenerated / recycled , (so) glycolysis continues ;</p> <p>7 correct ref to , pyruvate decarboxylase / ethanol dehydrogenase ;</p>	3 max	<p><b>CREDIT</b> glucose / maltose / maltotriose for 'sugar'</p> <p><b>2 IGNORE</b> fermentation</p> <p><b>5 CREDIT</b> NADH<sub>2</sub> / NADH (+H<sup>+</sup>) / red NAD</p>
3	(a)	(iii)	<p><i>ethanol is</i> produced in , <b>all</b> yeast growth phases / <b>all</b> of the time</p> <p><b>or</b></p> <p>production of ethanol increases as yeast population increases</p> <p><b>or</b></p> <p><i>idea that</i> ethanol is a normal (metabolic waste) product (of yeast) ;</p>	1	<p><b>IGNORE</b> ref to ethanol not being a secondary product</p> <p><b>CREDIT</b> 'produced during normal growth'</p> <p><b>CREDIT</b> follows growth curve for yeast</p> <p><b>IGNORE</b> waste unqualified</p>

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3	(a)	(iv)	<p>1 sugar <u>concentration</u> falls <b>too</b> low ;</p> <p>2 pH falls <b>too</b> low / conditions become <b>too</b> acidic / decrease in pH causes enzymes to denature ;</p> <p>3 high ethanol <u>concentration</u> , damages / poisons / inhibits , yeast ;</p>	2 max	<p>1 <b>ACCEPT</b> very low sugar concentration / sugar concentration decreases as used up</p> <p>2 <b>ACCEPT</b> very low pH / very acidic <b>DO NOT CREDIT</b> 'falls and rises'</p> <p>3 <b>ACCEPT</b> high ethanol <u>concentration</u> kills yeast</p>
3	(b)		<p>1 glucose can , be used / enters glycolysis , directly / without being broken down (first) ;</p> <p>2 maltose, must , be <u>hydrolysed</u> / have <u>glycosidic</u> bonds broken ;</p> <p>3 enzyme / maltase , only made when , needed / maltose present / glucose running out ;</p> <p>4 enzyme induced / gene(s) switched on ;</p> <p>5 transcription <u>and</u> translation / protein synthesis , takes time ;</p> <p>6 maltotriose requires, more (2) <u>hydrolysis</u> (reactions) / breaking of more (2) <u>glycosidic</u> bonds <b>or</b> enzyme to break down maltotriose made last ;</p>	3 max	<p><b>ACCEPT</b> 'monosaccharide' for glucose and 'disaccharide' for maltose and 'trisaccharide' for maltotriose throughout</p> <p>1 <b>IGNORE</b> ref to glucose being used first / at start / immediately (as stated in Q)</p>

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3	(c)	<p><i>advantages of using yeast</i></p> <p><b>A1</b> less energy required ;</p> <p><b>A2</b> does not need , high temperature / 300°C / high pressure ;</p> <p><b>A3</b> can use waste material (as a substrate) ;</p> <p><b>A4</b> substrate is , sustainable / grown each year ;</p> <p><b>A5</b> process does not use up , oil reserves / fossil fuels ;</p> <p><b>A6</b> product is carbon neutral / no carbon footprint ;</p> <p><b>A7</b> AVP ;</p> <p><i>disadvantages of using yeast</i></p> <p><b>D1</b> time consuming / takes several days ;</p> <p><b>D2</b> needs , downstream processing / purification of product ;</p> <p><b>D3</b> is killed by product ;</p> <p><b>D4</b> can (only) use batch method ;</p> <p><b>D5</b> aseptic / sterile , conditions required ;</p> <p><b>D6</b> AVP ;</p>	5 max	<p><b>CREDIT</b> statements relating to yeast method only</p> <p><b>IGNORE</b> statements relating to chemical method</p> <p><b>IGNORE</b> ref to cost</p> <p><b>A2 ACCEPT</b> works well at low , temperatures / pressures</p> <p><b>A3 CREDIT</b> example e.g. sugar cane waste</p> <p><b>A6 IGNORE</b> ref to global warming / greenhouse gases</p> <p><b>A7</b> e.g. yeast is readily available / easily accessible / yeast is in plentiful supply / yeast has simple growth requirements / process is less hazardous</p> <p><b>D1 ACCEPT</b> slower rate of reaction</p> <p><b>D2 ACCEPT</b> need to separate ethanol from yeast</p> <p><b>D3 ACCEPT</b> is inhibited by product</p> <p><b>D5 ACCEPT</b> more likely to become contaminated</p> <p><b>D6</b> e.g. concentration of ethanol produced is limited</p>
		QWC ;		1
<b>Total</b>			<b>19</b>	

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4	(a)	<p>1 less ventilation / <i>Idea of</i> difficulty in exhaling due to less recoil / small surface area for gaseous exchange / less oxygen entering capillaries / less oxygen entering blood ;</p> <p>2 less oxygen (reaching cells) for , (aerobic) respiration / oxidative phosphorylation ;</p> <p>3 (so) less ATP produced ;</p> <p>4 <i>idea of</i> increased acidity (as CO<sub>2</sub> / lactate builds up) interfering with / affects , enzymes / respiratory metabolism ;</p>	2 max	<p><b>IGNORE</b> 'produces' energy in any mark point</p> <p>1 <b>DO NOT CREDIT</b> no oxygen</p> <p>2 <b>DO NOT CREDIT</b> no respiration</p> <p>3 <b>DO NOT CREDIT</b> no ATP</p>
	(b)	<p>1 not enough / less , glucose uptake into <u>cells</u> ;</p> <p>2 not enough / less , glucose / substrate , for , respiration / ATP production ;</p> <p>3 glucose not , stored as / converted to , glycogen ;</p>	2 max	<p><b>ACCEPT</b> 'sugar' for glucose</p> <p><b>IGNORE</b> (excess) glucose lost in urine (as does not answer the Q)</p> <p><b>Only CREDIT ora</b> if candidate clearly states that the sequence of events does <b>not</b> happen in this case</p> <p>1 <b>DO NOT CREDIT</b> no glucose uptake</p> <p>2 <b>IGNORE</b> produces energy <b>DO NOT CREDIT</b> no respiration / no ATP / no glucose</p>

Question		Expected Answer	Mark	Additional Guidance
4	(c)	<p>1 <i>idea of</i> slow rate of / sluggish , blood flow <b>or</b> low(er) blood pressure ;</p> <p>2 less / irregular amount of , oxygen (reaching cells) for , (aerobic) respiration / oxidative phosphorylation ;</p> <p>3 less glucose (reaching cells) for respiration ;</p> <p>4 (so) less ATP produced ;</p> <p>5 <i>idea of</i> increased acidity (as CO<sub>2</sub> / lactate builds up) interfering with / affects , enzymes / respiratory metabolism ;</p>	2 max	<p><b>IGNORE</b> 'produces' energy in any mark point</p> <p>1 <b>IGNORE</b> 'heart doesn't beat strongly enough' or 'heart beat is inefficient' <b>IGNORE</b> ref to volume of blood without time/rate</p> <p>2 <b>DO NOT CREDIT</b> no oxygen / no respiration</p> <p>3 <b>IGNORE</b> sugar <b>DO NOT CREDIT</b> no glucose / no respiration</p> <p>4 <b>DO NOT CREDIT</b> no ATP</p>

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4	(d)	(i)	<p>1 less pyruvate for , link reaction / Krebs cycle <b>or</b> link reaction / Krebs cycle , cannot take place / reduced <b>or</b> only / mainly , glycolysis takes place ;</p> <p>2 no / little , oxidative phosphorylation ;</p> <p>3 less , energy / ATP , for muscle contraction / resulting in muscle weakness / for mental processes ;</p> <p>4 <u>anaerobic</u> respiration takes place ;</p> <p>5 lactate / decrease in pH , causing aching muscles ;</p>	3 max	<p>2 <b>IGNORE</b> produces energy</p> <p>3 <b>DO NOT CREDIT</b> no ATP <b>IGNORE</b> produces energy <b>IGNORE</b> muscle fatigue</p> <p>5 <b>CREDIT</b> 'lactic acid' instead of 'lactate' <b>ACCEPT</b> muscle cramps</p>
4	(d)	(ii)	<p>1 <i>idea that</i> B lymphocytes do not respond to cytokines (that have been produced) ;</p> <p>2 little , energy / ATP , for B cell , mitosis / clonal expansion ;</p> <p>3 little , energy / ATP , for , production / release , of antibodies ;</p>	1 max	
			<b>Total</b>	<b>10</b>	